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ABSTRACT

This report, a review of literature combined with two case studies, poses the question of whether tactual resources-hands-on, manipulative materials--help reduce college attrition and foster development of necessary academic skills. At George Mason University (Virginia), an exploratory, embedded case study was designed to investigate experiential learning at the doctoral (Case Study One) and the undergraduate (Case Study Two) levels. The major proposition for the first group was, "If doctoral students construct tactual resources and observe undergraduates using them, they will be more likely to use manipulative materials in subsequent teaching at the community college level." In the second case study group, a separate hypothesis was pursued: "If provided tactual resources with information specific to their course evaluation, students will willingly use the materials for study purposes." Generally, it was concluded that tactual resources are helpful in student learning and persistence. Learning how to construct and implement this type of learning at the college level, however, requires the effort to learn new teaching and learning routines, and a commitment to the belief that all students can learn once the appropriate teaching methods are developed. (Contains 29 references.) (EMH)

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Tactual Resources at the College Level: Toys for Adult Learning

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RUNNING HEAD: Adult Toys for Learning

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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

"I'm really excited about teaching at the community college level," said Bill, a career intelligence analyst for the military. "I love American history and think I'll do a good job with the content. The problem is," he confided to the nine other doctoral students enrolled in an elective course on teaching at the community college level, "I'm not certain how to work with students who don't like to read and who may be at high risk for college failure for various reasons."

Bill's concerns were well founded. The State Council of Higher Education for Virginia found that 24 percent of that state's community college and university undergraduate students require "remedial work before tackling college classes" (Morrison, 1996). Claxton and Murrell (1987, p. 1) argued that the "need to improve educational practice is great," and college administrators point to high rates of attrition, increased diversity of student needs, and lack of preparation for college work by large numbers of entering freshmen as rationale to make changes (O'Hanlon, 1997). It is little wonder that students who leave college before completion, do so during their first semester of their freshman year (Nelson et. al., 1993). Bill's concerns reflected thoee statistics, because many students enroll in American history during their freshman year.

Learning Styles Instruction

Reducing academic failure of college students "requires more than traditional remedial and study-skills orientations and supportive services," argued Barbara Nelson, Assistant Vice President, St. John's University, and her colleagues (Nelson, 1993, p. 34). They found that traditional approaches to remediation were ineffective for large numbers of students—especially students who prefer to learn actively with materials they can handle and manipulate. Consequently, faculty at St. John's University began teaching students based on their self-

identified learning style preferences. As a result, they reduced attrition by 19 percent while students made significant academic gains.

Teaching according to how students learn was advocated as early as 1945 by Vicktor Lowenfeld (1945) who challenged the practice of testing low achieving students with paper and pencil tests. He theorized that 25 percent of college students gain most of their information through touch and movement, yet most coursework at that time was lecture-based followed by paper and pencil examinations—a predominant practice that continues today. Subsequent research demonstrated that college students learn faster and more effectively when learning opportunities match their individual learning styles and/or when students are taught to use their learning style strengths for completing homework (Clark-Thayer, 1987; Claxton & Murrell, 1989; Cook, 1989; Dunn, Deckinger, et al., 1990; Dunn, Sklar, et al., 1990; Griggs, et. al., 1994; Lenehan, et al., 1994; Lowenfeld, 1945; Nelson et. al., 1993).

Bill's class, EDCC 802, Community College Teaching through Learning Styles, was created to explore how to effectively address different ways community college students learn. Thus, based on the above discussion, tactual materials seemed like a reasonable place to begin. Packaging course content into hands-on/manipulative materials may be an effective way to modify teaching and reduce high attrition rates. The concept was well worth exploring.

Tactual Teaching at the College Level

It is one thing to philosophize and discuss teaching though individual learning styles and quite another thing to do it. Griggs and Griggs (1998, pp. 5-6) outlined several steps for getting started. Paraphrased they were:

1. Identify and administer a learning-style assessment instrument that is appropriate for adults and has strong reliability and validity (Beyler & Schmeck, 1992; Curry, 1987; DeCoux, 1990; LaMothe, et al., 1991).
2. Provide interpretations of the results to each student, explain students' individual strengths, and provide descriptions of how best to study to take advantage of learning style strengths (Dunn & Klavas, 1990).
3. Use a variety of instructional delivery approaches to accommodate students' varied perceptual and social preferences including lectures, small-group discussions, team learning exercises, individual activities, audio- and video tapes, case studies, mapping, and experiential activities that encourage movement.
4. Permit the use of tape recorders, variations in lighting and opportunities to stand, sit or lounge while engaged in learning.
5. Begin lessons with an overview, a content-related, human-interest or anecdotal story, or a humorous example of how the content relates to students' lives. This brings learners into the content and accommodates those who need a perspective of the whole before dealing with details.

Evidence that these techniques work was found in a meta-analysis of 36 experimental studies with a database of 3,181 participants (Dunn, et al., 1995). This meta-analysis revealed that overall academic achievement was three-fourths of a standard deviation higher for participants whose instruction matched their learning styles compared to those not accommodated. Across the 36 studies, adult learners made greater significant gains than elementary or secondary students when instruction matched preferences. Further, matching

physiological preferences--perceptual strengths, time of day, movement and food intake while learning--had a greater impact than matched elements in other domains.

Nothing was reported in the meta-analysis about how college students used tactual materials, but it may be speculated that the benefits of tactual resources for college students were dependent upon several variables: 1) student preference for hands-on learning, 2) student willingness to use tactual resources if provided, 3) instructor willingness to provide manipulative resources, 4) physical appearance of the resources, and 5) student willingness to construct self-correcting manipulative learning aids.

An unwillingness to construct self-correcting tactual materials was illustrated in a study by Dunn, Deckinger, Withers, & Katazenstein (1990). They found that after sharing the benefits of completing homework through learning-style preferences, "some students demonstrated interest in the suggestions; others were skeptical and/or noncommittal" (p. 100). Out of 47 students in their study, only ten agreed to implement the researchers' homework suggestions. Those ten achieved significantly higher scores than did either of two control groups that did not modify their homework approaches.

Posing the Question

Doctoral students in Bill's class remained ambivalent and skeptical about using tactual resources in college classes. Then Ed forced through the doubt by saying, "It seems to me that if education is to experience any lasting reform, two things are critical. First, teachers must fundamentally change with regard to what they believe about how students learn. Second, educators across the board must seriously rethink how teachers teach."

Ed's statement provided an opportunity for the professor to suggest a class project whereby doctoral students would make tactual resources for students in an undergraduate course

and determine for themselves if hands-on learning was a viable instructional option for community college teaching. Trepidation was voiced about spending time with scissors and glue, but after thoughtful discussion, students expressed interest and agreed to turn the opportunity into a mini research project. They were unaware of the fact that the professor was exploring the mini research effort as a way to investigate tactual learning at the doctoral level. Thus, doctoraal students were participants in the professor's study just as the undergraduates were participants for doctoral students.

.The objectives of this article are to: 1) describe the class project as an exploratory effort into experiential learning at the doctoral level; 2) share insights into the use of tactual materials by undergraduates; and 3) describe how graduate and undergraduate college students assisted one another in the learning process.

Setting

George Mason University (GMU), a state supported school in Northern Virginia, has a rich mix of ethnic groups from 49 states and 108 countries in its student population of 26,000. To address diverse student needs, GMU provides alternative undergraduate and graduate programs in addition to maintaining strong traditional programs (Lockemy & Summers, 1993; Terrey, 1991; Reich, 1991). **In 1996, 27 percent** of the freshmen class selected one of three alternative academic programs, with nine percent enrolled in New Century College (NCC)—the college population that most clearly resembled a cross section of community college students.

Students in NCC completed their freshman year in cohorts of 25 divided into five-member study teams. General education course content was integrated and taught in nine-credit units by faculty teams representing different disciplines. Students met four hours a day, four days a week for four six-week units. In addition, blocks of time were reserved for community-based

service learning and one-credit experiential classes. The class participating in this study was a one credit, experiential offering.

The Doctor of Arts in Community College Education (DACCE) program is equally innovative. It relies heavily upon extant coursework, since it emphasizes the teaching of a discipline. The collaborative nature of the DACCE program promotes cooperation among departments and colleges across campus and among local universities. In the fall of 1997, DACCE enrolled 215 students for study in 22 different disciplines.

Project Design

An exploratory, embedded case study design (Yin, 1984) was selected to investigate experiential learning at the doctoral (Case Study One) and undergraduate (Case Study Two) levels. This design was appropriate, because use of tactual materials had no clear, anticipated single set of outcomes for either of the two groups. Criteria for an embedded case study were met because: 1) boundaries between what was studied and the context were not clearly evident; 2) the primary data sources were direct observation and review of class documents; 3) there was a strong reliance on student self-reporting rather than on actual subject observation; 4) student behaviors could not be manipulated for purposes of the project; and 5) project artifacts--tactual materials, response questionnaires, and reflective essay--were constructed as part of the project (Yin, 1984, pp. 23-25).

The specific study question for Case Study One was: How can authentic learning-styles instruction be incorporated in a doctoral class on teaching at-risk community college students? The major proposition was: If doctoral students construct tactual resources and observe undergraduates using them, they will be more likely to use manipulative materials in subsequent teaching at the community college level.

The specific study question associated with Case Study Two was: How will undergraduate students respond to the use of tactual materials? Therefore, the major proposition was: If provided tactual resources with information specific to their course evaluation, students will willingly use the materials for study purposes.

Instrumentation

Students in both case studies completed the Productivity Environmental Preference Survey (PEPS) (Price, Dunn & Dunn, 1991)--a 100 item, self-diagnostic instrument designed to measure the learning style preferences of adults. Items on the 5-point Likert scale yield reliable and valid results as reported by Kirby (1979) and others (Buell & Buell, 1987, Clark-Thayer, 1987, Curry, 1987, Freeley, 1984). The PEPS provided personal learning preferences in five learning domains: 1) environmental (sound, light, temperature, and design), 2) emotional (motivation, persistence, responsibility, and structure), 3) sociological (working alone, in pairs, with peers or authority figures, and with various others), 4) physiological (perceptual modalities, intake, time of day preferences, and mobility), and 5) psychological (global/analytic, impulsive/reflective).

Numerous studies (Clark-Thayer, 1987, Cook, 1989, Dunn, Deckinger, Withers, & Katzenstein, 1990, Dunn, Bruno, Sklar, Zenhausern, & Beaudry, 1990, Lenehan et al., 1994, Mickler & Zippert, 1987, Nelson et al., 1993) document significant results when matching instruction and/or study habits to learning preferences as identified by the PEPS. For example, after assessing 1,000 minority college students in remedial mathematics classes, Dunn and her colleagues (1990, May/June) revised every other chapter in the students' analytical step-by-step textbook to accommodate a global processing preference. Students studied on their own without

direct teacher instruction and gained significantly higher test scores ($p < .001$) on chapters that matched, rather than mismatched their global or analytic style.

Procedures for Case Study One

The objective of Case Study One was to investigate how to incorporate authentic learning-styles instruction into a doctoral class on teaching at-risk community college students. Several techniques were used to make the course both experiential and highly relevant to real-world needs. Chief among them was the development and execution of a class-directed mini research project.

The common student goal of the ten DACCE students was to develop skills and strategies for teaching students at high risk for college failure. The five women and five men ranged in age from 32 to 54 years and reflected GMU's ethnic mix. Their occupations included: vice president of insurance training, systems analyst, intelligence analyst, data administrator, community college instructor, community college administrator, software systems engineer, family therapist, public school curriculum specialist, and accountant.

Nine of the ten doctoral students completed the PEPS and used their feedback to develop a greater understanding of self and others for instructional purposes. Their strong modality preferences were auditory (2 prefer), visual (2 do not prefer), tactual (5 prefer), and kinesthetic (2 prefer)—two students had strong preferences on two elements. This mix demonstrates a strong adult preference for tactual learning in excess of that anticipated for a group of doctoral students with higher education teaching as a goal.

Involvement with the undergraduate exploratory case study was a semester-long endeavor and became a part of each of the 14 class sessions. None of the students realized the doctoral class was also part of the study. Classroom discussions and e-mail communications that

served as data sources included: 1) types and quality of tactual resources constructed; 2) group problem solving in terms of data collection and analysis; 3) observations of undergraduates using their tactual resources; 4) the professor's observational notes of doctoral students as they observed undergraduates; and 5) students' reflective essays regarding their use of tactual materials as community college professors, and their involvement in this highly experiential learning course.

In the first six-weeks of class, doctoral students were introduced to concepts and research underlying learning styles instruction and its application to the college classroom. Students designed and made self-correcting tactual resources such as flip chutes, electroboards, and task cards (Dunn & Griggs, 1995) for a set of questions pertaining to the undergraduate course content. As might be expected, these resources varied in size, color, complexity of design, and aesthetic appeal. Each resource was critically reviewed by two other members of the class and refined or replaced as appropriate before being used by the undergraduates.

Following this period of resource preparation, the class focused on administrative and logistical issues such as objectives of the undergraduate study, type of data to collect, development of feedback questions regarding reactions to the resources, determination of observation dates, and selection of data analysis procedures.

Observations were conducted during one of the two scheduled undergraduate class sessions in which students were asked to use and critique a total of three different tactual resources. Doctoral students sat along one wall or circulated around the classroom to watch undergraduate reactions while one doctoral student took photographs.

Teams of two doctoral students analyzed the undergraduate responses, and Margaret completed a spreadsheet of the quantitative data. Nora entered undergraduate PEPS scores and

their final quiz scores in SPSS format and constructed graphs to note if any meaningful relationships existed between modality preferences on the PEPS and scores earned on the final quiz. The class worked collectively to summarize the results and discussed possible interpretations.

Ed wrote a preliminary draft of the study, and the class reviewed it for content accuracy and offered suggestions for revision. The professor described the overall research design and developed a second draft. The class edited it for publication consideration before Ed, Bill and the professor took responsibility for final revisions and submission for publication.

Results of Case Study One

Data were generated from multiple sources: observations, e-mail communications, and reflective essays. Each source added richness to the overall study.

Observations. In their enthusiasm to see how undergraduates responded to the tactual resources, some doctoral students walked around to more closely observe undergraduate reactions, or to interact with the undergraduates. They all held whispered conversations during the observation phase., and the group's photographer tended to arrange undergraduates for composition purposes rather than take photos as unobtrusively as possible.

One man voiced concern about his classmates' failure to respect the integrity of the observation process. Except for this student, there was little or no articulated attention to how the observers may have influenced those observed.

E-mail Communication. Review of the e-mail communications revealed a lively interchange throughout the course. Much of it extended course inquiry beyond content discussed in class. There was a limited amount of chit-chat but a tendency to 'take care of business' while

on-line, sign off, and then bring their ideas and materials to class where they could share in person. Thus, e-mail interactions were effective for transacting class business between sessions.

Reflective Essays. Entries in reflective portfolios were mixed regarding reactions to: a) how they might use tactual materials as community college professors, and b) their reactions to participation in this highly experiential learning course. One woman who scored at the moderately strong level for 'does not prefer' tactual learning on the PEPS wrote:

> The new design of learning/teaching devices introduced in EDCC 802 opened new avenues for approaching certain topics in my Spanish language classes. The tactual resources required an inordinate amount of design and construction time, but the final effort was rewarding. I used several of them for successfully teaching aspects of grammar which are often repetitious and tiring. The students, who ranged in age from 20 to 70, were amused at first, but each one commented favorably about the interesting aspects of the tactual devices. "It puts a new slant on the verb to be," they said, jokingly.

Two women who had previously viewed themselves as visual learners were surprised when results of the PEPS revealed a strong preference for tactual learning. Liz wrote:

> I did not consider myself a tactile learner, and could not see students using the tactual resources as well. However, . . . I created several resources for myself as study tools during previous classes; I just didn't identify them as tactual resources. The discussions that followed via e-mail and in class helped me realize the significance and value of tactual resources in a teaching environment. I don't think I would have had the same response had we not gone through the steps to develop, discuss, and see tactual resources in use in another class.

One man who scored as a strong tactual learner created several especially attractive, clever resources that were engaging and easy to use. He wrote:

> I believe that learning is enjoyable and perhaps an intoxicating experience when the experience provides an opportunity for one to indulge in his or her dreams or passions. The opportunity to design and build tactual resources was one such experience because it permitted me to indulge in my artistic desires. For the past four years, as a result of my professional and doctoral program demands on my time, I have had to restrict my indulgence in the arts. Thus, I welcomed the tactual resource activity with glee.

By contrast, one woman with a strong preference for auditory learning and a strong preference against visual learning offered the following response when asked if she would make tactual materials for her students:

> No, I would not create these resources, however, I will take a more hands on approach to teaching in my subject area. I would not use these tools because of the extra time it takes to create them. However, it is definitely a good suggestion to offer to students.

Discussion of Case Study One

During the semester, doctoral students were encouraged to use the course as a catalyst for developing specific materials for courses they taught or planned to teach. They willingly constructed materials and many developed additional resources for future use. In spite of heavy course demands, full-time employment, and family responsibilities, their efforts clearly demonstrated that construction and implementation of authentic tactual resources was a viable and rewarding way to make a doctoral course highly relevant. Whether this would be true of a

class where half the students are strongly auditory or visual rather than tactual remains to be explored.

Procedures for Case Study Two.

The 16 undergraduate NCC students enrolled in an intensive two-week, one-credit elective course on how the brain functions. They met two hours and forty minutes each of five sessions in addition to out-of-class responsibility for viewing selected videos and reading selected references. The four men and 12 women reflected GMU's ethnic mix and age range. The majority of students were 18 years of age but the range went to age 45. There were six freshmen, four sophomores, three juniors, and three seniors, with intended majors ranging from undecided to premed.

Students received a profile of their PEPS scores and a printed description of how to use their strengths for homework completion. They were asked to modify their study routines and take advantage of their identified strengths which included: auditory (5 prefer), visual (3 prefer, 2 do not prefer), tactual (4 prefer, 1 does not prefer), and kinesthetic (1 prefer, 1 does not prefer). Three students had documented learning disabilities. Students could work alone or with others for out-of-class assignments, while in-class assignments were generally relied on small group interaction. Each student had completed at least one experiential course or semester in the NCC curriculum.

Class sessions were a mix of mini-lectures with color slides, role playing, physical activities, and small group discussions of books, articles, and videos. In addition, an internationally known neuroimager gave one slide lecture and students took a field trip to a brain research laboratory. On two days during class time, undergraduates used the tactual resources to study 20 questions and answers about the brain. Because of a fire alarm and two lengthy building

maintenance interruptions, students had only ten to fifteen minutes to work with each of three resources rather than the 20 minutes planned for each. After using a resource, students completed a questionnaire about their reactions. On the fifth day of class, students completed a quiz containing questions taken directly from the tactual resources and other sources.

Results of Case Study Two

Data sources for the undergraduate case study consisted of observations, questionnair responses, course quiz, and reflections. As with Case Study One, these provided a rich data base for analysis.

Observations. Students had two opportunities to work with tactual resources. With few exceptions, most students quickly selected a device, used it with focused attention, completed a questionnaire and then selected something else. They often said things like, "Hey, look at this. I like the way the card flips over." And "I never thought I'd be playing with things like this in college, but this is fun." One of the most popular devices was Rick's competitive electroboard called 'Brain Hoopla' that required two players. It was difficult to get students to relinquish it, so others could use it.

One man, with no identified modality preference, exclaimed as he chose Emma's colorful flip chute made from a mannequin head, "I've been looking and looking at that all through class and could hardly wait to try it out." One woman selected a flip chute but when she could not figure out how to use it, she became animated and said, "This is stupid. What the hell am I supposed to do?" After the device was demonstrated, she settled down and proceeded in a relaxed manner.

One student with a documented reading disability and a high preference for auditory input avoided using materials that were both auditory and tactual even though the professor

encouraged her to do so. She preferred to walk around. When asked why, she said she couldn't read the words. When assured that all the text was available through earphones, she continued to avoid the resources.

The undergraduates expected to be observed, however, they tended to cover their writing while completing the questionnaire. Some voiced sensitivity to how doctoral students might respond to critical comments, especially low marks. "Do you think their feelings will be hurt?" asked one woman after the observers departed, "but you said to be honest," she added quickly in her defense.

Questionnaire Responses.

Questionnaire feedback consisted of four statements scored on a rating scale of 5-4-2-1, with 5 being the highest appeal. Following are the statements and how they were scored.

Item 1: This resource was easy to figure out and use. Eighty-five percent of the resources were rated as easy to understand and use, and the overall rating for 64 percent was either 4 or 5. Generally, students rated the first resource used lower than subsequent ones. Several students noted that the first resource helped them understand the next ones better. Five students (15%) rated all three resources as confusing and difficult. Two of these students were strong auditory learners (one with a diagnosed reading disability), two were strong visual learners (one with a strong dislike for tactual learning), and the fifth person had no strong modality preference or learning disability.

Item 2: This resource is motivating. Seventy-three percent of the resources were rated as high (4 or 5) in motivation. Visual appeal (activity, color, and graphics) and ease of use significantly influenced the level of motivation, while other factors such as size and portability played lesser roles.

Highest in appeal were action-oriented resources such as "electroboards" with bulbs that lit to signal correct answers. Cartoon characters that appeared animated, resources using a golf tee, and brightly colored resources also motivated students and held their interest. Their comments ranged from: "very colorful. [It] motivates you to learn," and "It is motivating . . . but there's no color. . . . You'd think color would help the thinking process." The inclusion of pictures and drawings generated positive responses, but their absence did not have a negative influence.

Most of the resources had no accompanying instructions, because doctoral students thought they were self-explanatory. Most students understood what to do without hesitation, but others considered them too complex. A few were judged too juvenile. Overly complex or overly simplistic resources were typically rated quite low, while resources needing little time or effort to understand were usually rated high even though they were often more challenging.

The motivation item generated some of the most helpful feedback. For example, students said: "I liked the whole concept of the activity, however lack of instructions made it confusing." "It wasn't challenging enough, and not much reinforcement." "Sort of redundant after a while," and "Would work if subject [were] curious. . . [but] I don't know if it would work on a more apathetic personality."

Size was a factor only if students wanted a readily portable resource: "I really like the fact that it is one piece (easily portable for pre-test cramming)." Or, "aesthetically pleasing [and] a good size for what it is but I prefer a portable resource."

Item 3: This resource helped me remember the information better than other techniques I have used. Sixty percent of the responses indicated that the resource was more helpful than other learning techniques previously used. The four students with a strong tactual learning preference

gave the resources a mean rating of 4.2. Some comments supported these high marks such as "When I actually interact with what I'm learning I remember faster." And, "I'm pretty good at just memorizing things I read, but this kind of allowed me to look at everything at once and to absorb all the information." Other comments were more critical, "I'm curious to see if I answer correctly. Once known, I'm not inclined to memorize the answer but just accept the outcome and go on to the next question." One student was particularly critical about the self-correcting feature of all the resources. He wrote "Because there is some way of cheating, it did not help me to remember the information."

Item 4: If I were given a quiz today over the information included on the tactual resource, I would probably score _____. Not surprisingly, responses to this item gained in strength as students responded to the second and third resource operated. The mean student rating for resources on day one was 3.0 while it rose to 3.96 with the second and third resources. Even after working with the latter two resources, student estimates of their anticipated percentage correct on a quiz ranged from 10 to 100 percent except for one auditory learner with reading disabilities who said she would remember nothing. This is the same student who refused to use the resources designed for auditory learners. Insufficient time to work with the resources was given as the most frequent explanation for estimates of low performance.

Item 5: Would you make a tactual resource like the one you used? Forty percent said they would take the time to make a tactual resource for studying purposes, "If I had serious learning to do," said one, "because it helps me remember the information." And, "I believe I would because it was not easy for me to memorize." The simpler the resource design, the more likely students said they would make it.

Course Quiz. The quiz consisted of 14 questions drawn from the tactual resources and 19 questions with answers provided by e-mail. Results were compared to modality preferences, but no patterns emerged. The mean score earned on questions practiced with tactual resources was 81 percent correct, but no realistic analysis could be made with the e-mail questions since several undergraduates failed to read their e-mail messages and did not study for the at-home portion of the quiz.

Student Reflections. Only four of the 16 students rated as strong tactual learners, yet seven of them (44%) considered the tactual resources as being beneficial. One strong tactual learner with learning disabilities made the second highest score on the final quiz. She wrote

> "I really enjoyed the hands-on tactual materials. These materials really gave me the opportunity to through [sic] myself right into learning the functions and terms needed. I also liked the idea that they were colorful and game-like experiences. This made the materials easier for my [sic] to remember."

Discussion of Case Study Two

The number of students involved in this exploratory case study were too few to make any generalizations about the results other than those pertaining directly to the primary research question: How will undergraduate students respond to the use of tactual materials? This question was answered in terms of specific characteristics of tactual resources, observations of student involvement with the resources, and the favorable ratings the students gave for their use. Clearly, the number of students who indicated they would make and use tactual resources on their own was less than half but twice as many as the Dunn, Deckinger, Withers, and Katazenstein (1990) study noted earlier. Whether they actually would carry through with their intention was left unanswered.

A major reaction centered on the novelty of the resources rather than the content to be learned. Students had "fun playing with the tactual resources," but there was insufficient time the first session to move them successfully from novelty to content. By the time they were working with a third resource on the second day, focus seemed to shift to content. They took less time to manipulate experimentally and moved directly to the questions and answers.

Student comments reflected interest in using the resources and an assumption that more time would assist them in learning specific information. It is important to note, however, that tactual materials constructed for this study emphasized factual questions and failed to foster insight or problem solving for decision making. Thus, subsequent case studies should present tactual resources as authentic supplements rather than as memorization aids.

The overall conclusion was that undergraduates would use tactual resources if they were provided, but they probably would not make and use them on their own unless they were quick and easy to construct or if class time and materials were made available for their construction. Further, resources designed for use by one person provided private opportunities for study, but students valued more highly those that allowed for socialization and competition.

Closing Comments

The undergraduate research proposition--If provided tactual resources with information specific to their course evaluation, students will willingly use the materials for study purposes—was tentatively confirmed. Critical elements of the resources included their direct relationship to course content, novelty, motivation factors, aesthetic appeal, level of complexity/simplicity, and ease of use. Preliminary results of this exploratory case study strongly support further exploration with larger sample size, longer availability of time for use of tactual resources, and authentic integration within the coursework.

Results were positive but mixed with regard to the proposition, If doctoral students construct tactual resources and observe undergraduates using them, they will be more likely to use manipulative materials in subsequent teaching at the community college level. Doctoral students experienced all the frustrations of collaboratively designing an authentic research project including coordinating doctoral and undergraduate schedules, determining how to collect data, and deciding on techniques for data analysis. Ideas were discussed freely and, except for one student, focus remained on problem solving rather than on grades. Problem-solving/ decision-making exercises flowed smoothly, as one student or another offered suggestions and the entire class debated before decisions were reached collectively.

Ed poignantly summarized the ultimate lessons of the graduate course by stating:

> Whenever we commit ourselves to learn, I believe that we indulge in an opportunity for risk-taking. Depending on one's outlook, it is the risk of success or the risk of failure. Specifically, we may succeed in understanding a new concept; in gaining proficiency in a new knowledge domain; or in acquiring a new skill. On the other hand, we may fail. No matter the result, we are certain of one outcome--we would have learned from the experience. Thus, if we endeavor on a life-long commitment to learning, then we commit ourselves to make risk our business.

As a class we made risk our business, and we succeeded. To illustrate, Pat wrote in her reflective journal, "The class exceeded my expectations. I have been energized and motivated to continue learning about learning styles and perhaps to use this class as a springboard to my dissertation."

Without question, the embedded case study was an authentic learning experience for everyone involved. Would we do it again? Absolutely! We took risks, we learned from our mistakes, and we will make our next experiences stronger.

Will tactual resources help reduce college attrition and foster development of necessary academic skills? We believe they will. Learning how to construct and implement tactual learning at the college level, however, requires shifts in attitudes, hard work to learn new teaching/learning routines, and commitment to the belief that all students can learn once we develop approaches for teaching them. Without a doubt, teaching with tactual resources is an excellent place to begin that effort.

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